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THE EVIDENCE OF DIURNAL VARIATION IN CLOCK RATES

By R. H. Tucker

Meridian circle observations of standard stars show that there is a systematic difference between the clock corrections as determined at sunset and at sunrise. It amounts to about $0^s.06$ and can evidently be explained in but one of two ways. Either there is some systematic correction required for the observations of transits at the two epochs of the day, or the clock runs faster at night than during the daylight hours.

Attempts to explain the effect by the variations in atmospheric refraction which might be due to changes in the barometric gradient, or the thermal gradient, have shown that such causes could not be sufficient to account for the observed deviation.

We can shift our point of attack by deriving the observed clock rates during the night hours. It is not feasible to obtain clock rates during the middle of the day that would be precise enough to compare directly with night rates. Nor is this necessary. If the night rates are in excess of the average rate for an interval of twenty-four hours, the excess must be balanced by a deficit in the rates during daylight.

At night we have the advantage of the best observing conditions, with no evidence that is conclusive of the existence of any abnormal refraction effects, and we can make a sufficiently large number of observations to obtain a precise result, such as is required by the delicacy of the test. The result is independent of observations made at sunset and sunrise, but appears to be an entirely competent test of the observed deviations at those epochs of the day.

Variations of temperature of the clocks do not affect our results by any sensible amount. Our clocks are protected by double cases, in which the diurnal variation rarely exceeds a fraction of one degree, and the temperature at night lies almost invariably between those of the two adjoining days.

The following table gives the comparison of clock rates determined during the actual intervals of observation each night with the daily rates of the clocks at the same epochs. Negative signs indicate the amount that the clock runs faster per hour than the average hourly rate during an interval of twenty-four hours. All the material upon which the table is based had been reduced and prepared for publication before this special computation was taken up. The results of observation up to 1905 have been printed in our meridian circle volumes.

YEARS	O-C	WEIGHT
1893 to 1894	—0^{s}.010	2
1894 to 1895	—0 .006	2
1895 to 1896	—0 .006	1
1897 to 1898	—0 .004	2
1898 to 1900	—0 .008	4
1901 to 1904	—0 .008	4
1905 to 1906	—0 .005	2
1906 to 1907	—0 .005	2
1907 to 1908	—0 .004	1
1914 to 1915	—0 .004	3
1917 to 1918	—0 .005	3
1920	—0 .004	3
Mean by weights	—0 .006	∓ 0^{s}.0004

Weights have been assigned according to the number of nights of observation in each tabulated interval. It is only by including observations of every hour of right ascension that the systematic errors of the adopted star places can be eliminated. Observations of special lists of stars could not be included, for this reason. Mean results for the separate intervals were carried out to four places of decimals.

The above observations were nearly all made between 8 P. M. and midnight, usually in periods of four hours' duration. A special series of observations is being made this year, extending from 9 P. M. to 3 A. M. each night of observation. These observations, about two thousand in number, may be expected to give a final direct test of the observed variation. Single nights will have a relative weight of ten, as compared with the usual series of night observations.

We still refer to the result as an observed phenomenon, since systematic corrections may be found to account for it. A persistent diurnal change in the position of our instrument, small enough to escape detection by our measures of instrumental corrections, might affect our observed hourly rates of the clock. Fatigue during observing periods might produce a change in personal equation in recording transits. A diurnal periodic variation in longitude, such as the known long term periodic variation (fourteen months), would appear as a diurnal variation in the observed meridian. All of these hypotheses will receive adequate attention in the full discussion of our latest observations.

We have transferred the method of solution, from the observed deviation of clock *corrections* at sunset and sunrise to the observed hourly *rate* of the clock during the night. The unit of the excess of a single hourly rate in the last method is about one-sixth the size of the unit of the first case. But for an observing period of six hours we have five successive hourly rates, and our unit per night is thus nearly as large as in the first case, with greatly increased material and of higher precision, since daylight observations are almost invariably of inferior quality.

In a paper presented at the August meeting of the American Astronomical Society, at Wesleyan University, a smaller average excess ($0^s.004$) was quoted, as the results of the first six intervals of the above table had not then been collected.